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OFFICE OF THE SECRETARY

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DOCKET FILE COPY ORIGINAL

January 11, 1994

By Hand

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, NW
Washington, DC 20554

Re: "Telephony and other Secondary Services Available through Suite 12's LMDS Frequency Plan"
Ex Parte Presentation
CC Docket No. 92-297
Local Multipoint Distribution Service

Dear Mr. Caton:

On behalf of Suite 12 Group ("Suite 12"), petitioner in the above-referenced rulemaking proceeding, enclosed please find two (2) copies of a study entitled "Telephony and other Secondary Services Available through Suite 12's LMDS Frequency Plan" which details the wide array of potential telephony, data and video applications of Suite 12's revolutionary technology for LMDS.

Please place two copies of this submission into the above-referenced docket. Any questions regarding this study should be directed to the undersigned.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Charles R. Milkis
William J. Gildea III
Counsel for Suite 12 Group

Enclosures

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January 11, 1994

By Hand

Dear Chairman Hundt
Commissioner Quello
Commissioner Barrett
Commissioner Duggan

Re: "Telephony and other Secondary Services Available through Suite 12's LMDS Frequency Plan"
CC Docket No. 92-297, Local Multipoint Distribution Service

Suite 12 Group ("Suite 12") today submitted the enclosed report entitled "Telephony and other Secondary Services Available through Suite 12's LMDS Frequency Plan," which details the wide array of communications services, including telephony and data, which Suite 12's revolutionary technology can provide in addition to video services for U.S. consumers.

The report explains how LMDS can be a competitive alternative in the local telephone loop — as a 1 GHz license can be used to provide approximately 136,000 simultaneous telephone calls per cell area. In other situations, depending on the particular needs of subscribers within an individual cell, LMDS can be used simultaneously to provide a combination of video and telephony/data applications.

Based on this wide array of telephony and video services that LMDS offers and their low cost relative to capital intensive coaxial and fiber-based technologies, LMDS, if licensed promptly, can play an integral role in providing universal access to the Information Superhighway. Accordingly, Suite 12 urges the Commission to conclude the LMDS rulemaking by adopting the Commission's previously proposed reallocation of the largely unused 28 GHz band for the pro-competitive LMDS, with the issuance of two 1 GHZ licenses per service area.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Counsel for Suite 12 Group

Enclosures
cc Acting Secretary William F. Caton (for inclusion in LMDS Rulemaking Record)

Telephony and Other Secondary Services Available Through Suite 12's LMDS Frequency Plan

by

• ***Bernard B. Bossard*** •

Suite 12 Inventor-Engineer

• ***Eric N. Barnhart. P.E.*** •

TELEPHONY AND OTHER SECONDARY SERVICES AVAILABLE THROUGH SUITE 12'S LMDS FREQUENCY PLAN

Introduction

Through the commercial waiver license granted to Hye Crest Management, Inc. in 1991, which authorizes the provision of 49 channels of video programming in the 28 GHz band in the New York metropolitan area, Suite 12 has demonstrated the commercial viability of its technology as a high-quality, low-cost alternative to cable television. This technology, which now is proven in the nation's largest media marketplace, can provide first-time multichannel video service to many of the areas not passed by cable.[1] Moreover, it can be implemented immediately throughout the United States.

However, LMDS is not simply an immediate competitive alternative to cable; it also serves as a low-cost wireless platform for telephony and data services. In fact, as this paper demonstrates, LMDS can be utilized as a competitive telephony alternative in the local loop throughout major U. S. markets. Moreover, the wireless telephony aspect of LMDS makes this technology particularly well-suited for developing countries, such as China, the twelve NIS Republics and South Africa, which often lack modern communications infrastructures which are so capital-intensive. Suite 12's technology for LMDS, as a valuable export commodity for the U. S., will provide such countries with comprehensive modern communications services, without the need to first build costly wireline infrastructures. These additional services are discussed in greater detail below.

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[1] Approximately 750,000 households in the New York metropolitan area alone are not wired for cable TV.

Through its array of potential services, LMDS can rapidly make the much-heralded Information Superhighway universally available to every home, business and university in the United States within a very short time period, whereas other technologies are very expensive to deploy, and/or are not technically feasible to service the American public on a broad scale. The FCC's prompt and appropriate deployment of LMDS in the 28 GHz band with two 1-GHz licenses per service area, as proposed in the LMDS NPRM, will:

a) provide a telephony alternative to traditional local loop services, with the inclusion of competitive alternatives for voice, data and teleconferencing services;
b) provide a high-quality, low-cost cable alternative to consumers throughout the U. S.;
c) create significant job opportunities for U.S. workers, including those in the technology-oriented defense sector, both in the manufacture of LMDS equipment and in the operation of LMDS systems;
d) allow the U.S. to set the appropriate 28 GHz technical standard for LMDS, and hasten LMDS deployment throughout the world;
e) provide the U.S. with an important export commodity, particularly throughout the developing world; and
f) generate substantial revenues for the U.S. treasury by the competitive auctioning of LMDS licenses from the grossly under-utilized 28 GHz spectrum.[2]

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[2] Greatly increased efficiency in the use of the 28 GHz spectrum is an integral part of Suite 12's cellular technology for LMDS since it reuses the same 1 GHz spectrum it is licensed to use in every cell, including adjacent cells. If nationwide deployment of LMDS occurs in the United States, several thousand cells would be in place. If the number of cells is conservatively estimated at 5,000, Suite 12's technology for LMDS would provide the equivalent of 5,000 GHz, or five million MHz of available bandwidth given the potential to customize available programming on an individual

(continued...)

The economic impact of job creation and universal availability of information resulting from the deployment of LMDS is compelling, particularly in view of the low-cost of LMDS, relative to capital-intensive coaxial and fiber-based services. While the Information Superhighway will include many different lanes through which to communicate, importantly, the prudent licensing of LMDS in the 28 GHz band has the potential to offer universal access to the broadband superhighway at reasonable cost, with a short-term deployment opportunity when compared to wireline alternatives.

Telephony and Secondary Services Implementation

As noted above, LMDS can also be used to provide a range of services in addition to video, such as telephony, data and video teleconferencing. If the Commission, as proposed in the NPRM, affords an LMDS operator with the discretion to determine what type of services to provide, whether video, telephony or data, or some combination thereof, LMDS operators will be able to respond to the particular needs of the marketplace on a cell-by-cell demographic basis, and consumers will best be served.

Suite 12's technology for LMDS allows flexible, on-demand use of the spectrum for a myriad of information services, including circuit-switched applications such as:

- voice telephony
- personal video telephony

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[2](...continued)
cell basis. There is no existing radio broadcast technology in the world today which so efficiently reuses the spectrum. Thus, when compared to any current use of the Ka-band of the radio spectrum, the Suite 12 technology represents the most innovative use known of the public spectrum resource.

- narrowband/broadband personal communications services
- ISDN multimedia services

and packet-oriented services such as:

- remote database query
- interactive entertainment
- personalized information services on virtual channels
- impulse pay-per-view and other transaction processing
- electronic data interchange (EDI)
- and other services.

Suite 12's technology for LMDS will also provide a reliable physical medium for local bypass to inter-exchange carriers or circuit connection to the local exchange carrier and, consequently, will provide a mechanism for universal multirate digital access (UMDA) which does not now exist in the telecommunications marketplace. In essence, LMDS secondary services can provide universal access to the emerging cell switching/Asynchronous Transfer Mode backbones which are becoming the "fast lanes" of the Information Superhighway.

The cellular nature of LMDS allows the bandwidth available for secondary services to be custom-tailored to the needs of residential, public/sector institution, and private-sector business users in the cell. This custom mix of interactive information infrastructure on a cell-by-cell basis represents an innovative, flexible, and upgradable advance in the state of the art in broadband multipoint information distribution. For example, cells zoned for business areas could offer telephony, tele-video and data services, while cells zoned for retirement areas could offer local shopping, banking and other consumer-oriented services.

The LMDS secondary services infrastructure can be easily installed—it involves only the terminal and communications equipment that is common to both wireless (i.e., LMDS) and wireline service installations, yet it requires no upgrade or retrofit of the wireline physical infrastructure itself, a process which carries with it high costs, both directly and also due to disruption of business, traffic, etc., in the construction phase. Modification of utility rights of way and the associated coordination between service providers, local government and private land owners is simply not necessary with LMDS. In addition, the low power nature of Suite 12's technology for LMDS allows for reliable continuous communications, even during power outages. Further, since the propagation medium is ether, little or no equipment maintenance is required, and any loss of service would affect individuals, rather than entire communities. It should be noted that Suite 12's LMDS transmitter can be fully redundant, with automatic failure switch-over.

The following are examples of various methods in which provision of additional services can be accomplished within the 1 GHz LMDS licenses proposed by the Commission:

a) LMDS Telephony Services: An LMDS operator can use the entire 1 GHz band for telephony and data services. Under this frequency plan, the capacity would be 17,000 to 136,000 (GMSK) simultaneous telephone calls, 518 (T-1) simultaneous video teleconferences, or 2500 (GMSK) video teleconferences in each cell.

b) LMDS Video-Telephony Combination Service: In the present LMDS video system operating in New York, there is 115 MHz of spectrum available between the 49 video channels (i.e., each 20 MHz channel has a 2 MHz guard band, with no LMDS signals on the NASA uplink Beacon frequency of 27.501 GHz) which can be used to provide digital voice, televideo, and data services to the consumer on a frequency assignment basis similar to that employed by the present cellular telephone industry. The use of the spectrum in this manner for a combination LMDS video/telephony system would allow an LMDS operator to carry over 3,000 simultaneous telephone calls per cell (30 kHz per channel), 120 T-1 lines, or 120 televideo conferences. The return path is provided within the received video spectrum and is isolated at the central node from the normal video distribution signals by use of spacial isolation and perhaps sector receive antennas. The use of sector node transmission will increase the capacity of secondary services by the number of sector antennas. For example, the use of 12-sector node antennas could allow for 36,000 simultaneous telephone conversations in a given cell. Frequency multiplexing or switching will be required at the central node if sector antennas are to be used. However, it is anticipated that sector antennas may not be required.

c) <u>LMDS Video Service</u>: As a video delivery system, the Commission's grant of two 1-GHz LMDS licenses, as proposed by the Commission in its January 1993 NPRM, will allow LMDS operators across the United States to immediately provide consumers with 49 channels (20 MHz bandwidth each) of "studio quality" video programming—programming which can be tailored to the demographics of a particular cell. Through various experimental licenses granted by the FCC, Suite 12 continues to aggressively engage in research, development and experimentation seeking to further advance its technology. In the future, such advances in the technology may allow an LMDS operator to provide more than 49 channels of video programming within a 1 GHz block of spectrum.

As noted earlier, a truly unique aspect of Suite 12's technology for LMDS is that, based on market demands, an LMDS operator can offer a combination of fewer TV channels and more telephony/data channels in those areas of a city dominated by business, such as Wall Street. In this manner, LMDS is a diverse, truly local service.

In addition, Suite 12 continues to use its experimental licenses in Los Angeles and New York to experiment with dual co-located transmitters of special design, which enable both TV distribution and voice/tele-video/data signals to share the same spectrum without interference. While these experiments are preliminary, they are designed to further enhance the spectrum efficiency of LMDS and, thus, demonstrate the enormous untapped potential of LMDS in the 28 GHz band.

Secondary Service Power Level and System Performance

Figure 1 indicates the various power levels required by the subscriber receiver located in the fringe area in order to communicate with the central node or collecting point. Note that even at a 3-mile range in heavy rain (15 mm/hour), only 0.74 milliwatts (0.00074 watts) are required for a voice channel, compared to 0.6 watts for a cellular telephone. Most important, the transmitter power level required by the subscriber transceiver is greatly reduced for locations closer to the transmitter. This low power requirement can be easily verified by recognizing that a video channel presently requires 400 milliwatts of power in a 20 MHz bandwidth, or 0.00002 milliwatts per Hz (400 mw ÷ 20 million). Then, in a 35 kHz (56 kbps) channel, only 0.7 milliwatts is required (0.00002 x 35,000).

Figure 2 represents the normalized attenuation vs. the depression angle of the node transmitter antenna. This relates to the relative signal level from the transmitter.

Figure 3 is important since it represents the cell performance at any point, including free space attenuation, rain attenuation, obstacle attenuation and/or bounce attenuation. The curve is normalized to receive reception at 15,000 feet (2.84 miles) for convenience and is accurate for the full 3-mile cell radius. It should be noted that the C/N level at this point is over 29 dB, resulting in a picture quality signal to noise better than 53 dB on a clear day (58 dB with pre-distortion of transmitter) and a picture quality of better than 45 dB in an intense rainfall which occurs less than 0.1 percent of the time. From this curve, it is seen that the subscriber transceiver power needed is 7.5 dB less, or nearly six times less at a range of 10,000 feet (1.9 miles), and 17 dB less or nearly 50 times less at a range of 5,000 feet (or 0.00001 watts). These low power requirements allow for "flashlight battery" operation during power failures. The system can operate as a broadband independent communications service, without the power failures caused to businesses. The inter-city connections can be accomplished via teleports, local exchange switching centers or inter-exchange carrier points of presence.

Conclusion

Based on Suite 12's current cable alternative system in New York and the demonstrated experimental use of LMDS in telephony and related voice and data areas, it is clear that LMDS offers a wide array of telephony, voice, data and video services to consumers. In view of the relative ease and low cost of deploying LMDS, LMDS can serve an important role in providing universal access to the Information Superhighway, allowing persons of all social and economic classes to enjoy state-of-the-art communications and access to information.

FIGURE 1

DATA MODULATION EXAMPLE

Transmitting amplifier power

Bandwidth (KHz)	Power (mW)	Data Rate (KBPS)
30	0.63	48
35	0.74	56
160	3.4	256
965	20.3	1,544
28125	590.[illegible]	45,000

Bandwidth Efficiency: 1.6 bits/Hz

Modulation: QPSK with 25% excess bandwidth

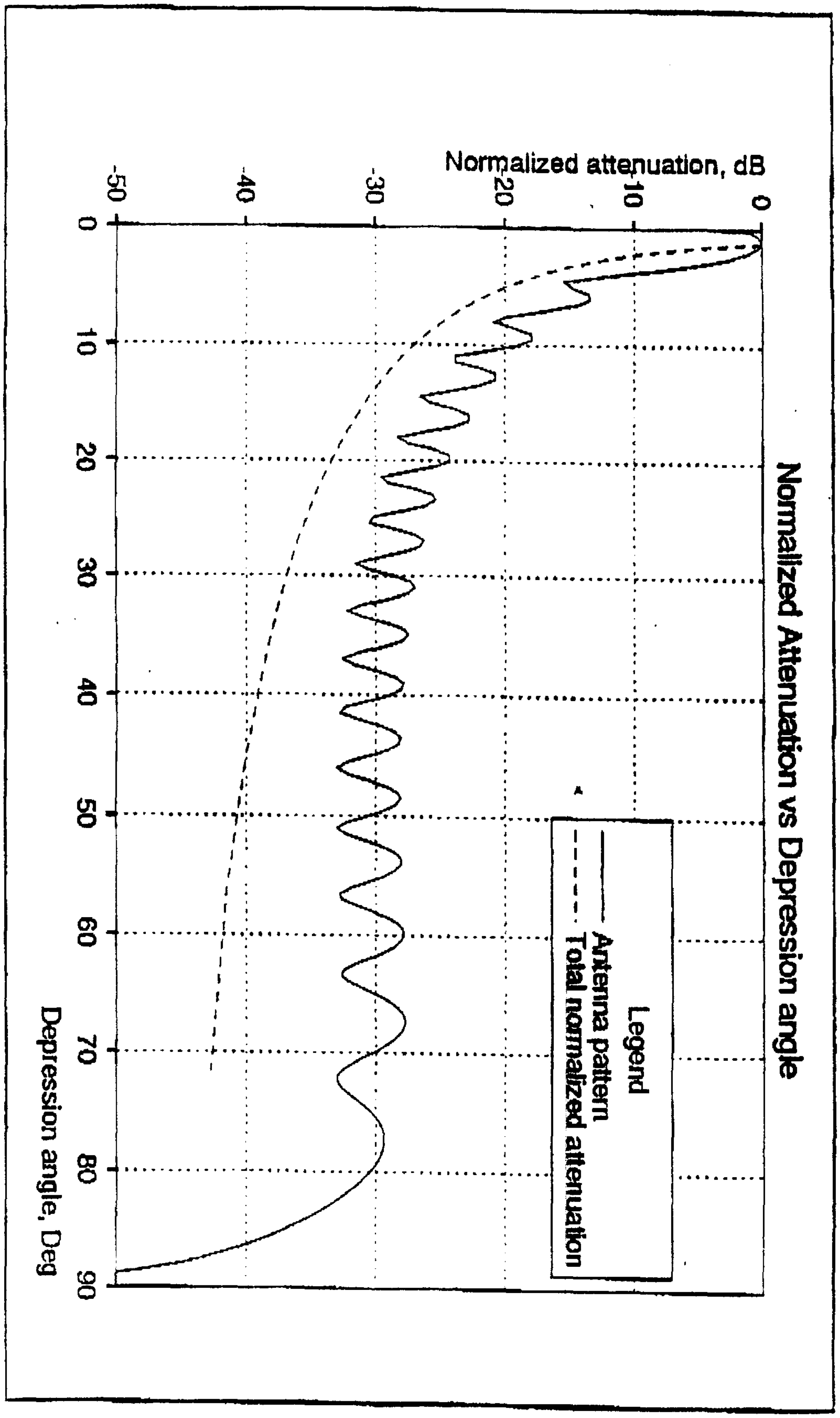
Data rate is channel rate

CNR: 13 dB

Rain Availability: 99.9% in average year

Link distance depends on city

FIGURE 2



Normalized Attenuation vs Depression angle
Normalized attenuation, dB
0
-10
-20
-30
-40
-50
0
10
20
30
40
50
60
70
80
90
Depression angle, Deg
Legend
Antenna pattern
Total normalized attenuation

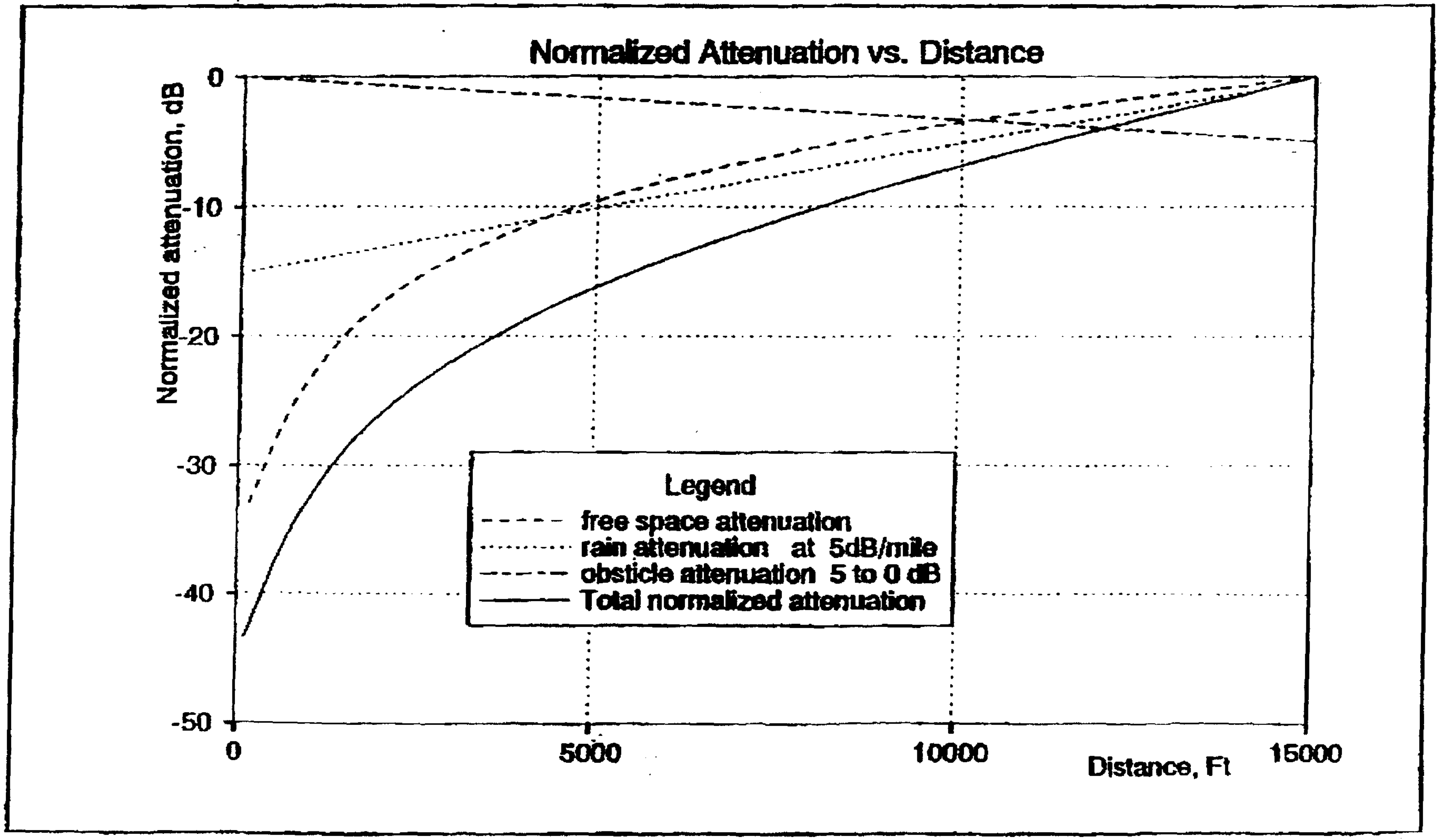

Normalized Attenuation vs. Distance
Normalized attenuation, dB
0
-10
-20
-30
-40
-50
0
5000
10000
15000
Distance, Ft
Legend
free space attenuation
rain attenuation at 5dB/mile
obsticle attenuation 5 to 0 dB
Total normalized attenuation

FIGURE 3

APPENDIX

BERNARD B. BOSSARD

EDUCATION: Virginia Military Institute, BSEE

EMPLOYMENT BACKGROUND:

1990-Present

Partner, CellularVision, Inc.

1977-1990

President, I/TTIC
Designed packet switch and microwave communications network under two contracts totaling over $4,000,000.

Senior Vice President and Group Publisher, Horizon House-Microwave, Inc. Responsible for the publication of Microwave Journal. The Journal of Electronic Defense, and Telecommunications magazines. These publications had a circulation of 200,000 plus).

1973-1977

Manager, M/A-COM (KMC Division)
Focus on development in research, development and application of new products. Upon leaving M/A-COM a non-competitive agreement prevented employment in microwave industry for a period of time.

1970-1973

General Manager, KMC Semiconductor Corp.
KMC was the first company to manufacture transistor (above 1 GHz). In addition to transistors, KMC produced tunnel diodes, back diodes, varactors,, solid state amplifiers and small sub-systems. The company was purchased in 1973 by M/A-COM (Microwave Associates) and is now part of their semiconductor operation.
Developed high dynamic range interference reduction circuits and target identification techniques for U.S. government.
Co-developed key Patriot Missile interference reduction device.

EMPLOYMENT BACKGROUND continued:

1968-1970

President, National Electronic Laboratories
Founder of electronic company engaging in research ans development of solid state devices
The company merged with KMC Semi-conductor Corporation in 1970..

Consultant for Engleman Microwave and KMC Semiconductor Corp.

1959-1968

Group Leader, RCA Communications
Responsible for a group of engineers engaged in research and development contracts in microwave communications. various solid state devices, system engineering, signals in noise, laser, super conductors and interference reduction devices.

1957-1959

Engineer, United States Army Research Laboratories
Developed low noise parametric amplifiers, anti-jamming techniques, millimeter wave radar and target identification radar.

TECHNICAL BACKGROUND:

1. Technical Leader of Research and Development:
   a) Interference reduction technology
   b) Anti-Jamming concepts
   c) Super conductors
   d) Parametric amplifiers
   e) High level convertors
   f) High "Q" filters
   g) Linear receivers
   h) Major communications system designs
   i) Solid state devices
   j) Solid state multipliers and oscillators
   k) sub systems for governmental applications
   l) Lasar modulation television

2. Low noise amplifier advisor to Dynsoar, Relay Satellite, and Lunar Excursion Radar Module

TECHNICAL BACKGROUND continued:

3. Consultant to U.S. Government on Radar Target Identification Techniques

4. Developed the first published parametric amplifiers with voltage gain bandwidth products as large as 1300 at S-band and tunable parametric amplifiers with noise figures of 1.0 dB

5. Developed first published high level parametric upconverter theory and device

6. Co-developed filter concepts which result in unloaded "Q" at 100,000 at room temps

7. Co-developed interference reduction techniques which improve receiver intermodulation distortion performance by 50 dB.

8. Developed linear voltage tuning, broadband high power and high efficiency varactor multipliers for use throughout the microwave region

9. Developed 130 dB dynamic range (-3 dB compression and 1 MHz bandwidth) frequency converters

10. Developed superconducting "X" band filter and amplifiers

11. Designed cellular Television system for commercial use

12. Co-developed critical Patriot Missile module (thousands used per receiver)

13. Expert witness on radar in court for the states of New Jersey and Massachusetts

14. Co-designed TRC-97

15. Program leader for numerous RCA internal research and development projects and government research contracts

AWARDS:

Nominated by RCA for Outstanding Young Engineer in America given by Eta Kappa Nu, National Engineering Honorary Society, 1966

U.S. Government Sustained Superior Performance Award, 1959

Team Engineering Award, RCA

Zero Defects Award, RCA

OTHER:

Chairman, Monolithic Circuits Sessions, MTT's Symposium, 1988

Lecturer, Satellite Communications, Northeastern University, 1986

Guest Lecturer on superconductors, National Science Foundation, University of Colorado, 1965

Guest Lecturer on noise and intermodulation distortion, University of Pennsylvania, 1964-65

Guest Lecturer on low noise technique at Stanford University, Georgia Institute of Technology and Pratt Institute of Technology

Who's Who in the East

Member, Board of Directors of several communications and microwave companies

Guest Lecturer, Communications Systems

PATENTS ISSUED:

Superregenerative Reactance Amplified Number 3,045,115 United States

Variable Frequency Oscillator Number 3,102,978 United States

Low Power Multi-Function Cellular Television System Number 4,747,160 United States and Foreign

PUBLICATIONS AND PRESENTATIONS:

1. Bossard, B. "Superregenerative Reactance Amplifier", Proc. IRE Volume 47, PP 1269-1271 July 1959

2. Bossard, Frost, Fishbein, "X-Brand Superregenerative Paramp", Pro.IRE, July 1960

3. Pettai, Bossard, Weisbaum, "Single Diode Parametric Upconvertor with Large Gd in Bandwidth Product", Proc. IRE, Volume 48, July 1960

4. Bossard, Pettai, "Broad Parametric Amplifiers by Simple Experimental Techniques", Proc. IRE, Volume 50, March 1961

5. Perlman, Bossard, :Efficient High Level Parametric Frequency Convertors", Proc. IEEE, Volume 51, February 1963

6. Bossard, Pettai, "Broadband Parametric Amplifiers", PGMTT Symposium, Bolder, Colorado, 1962

7. Bossard, Pettai, "Parametric Amplifiers", AIEE Convention (Invited Paper) 1962

8. Bossard, Kurzrok, "Comments on Broadband Parametric Amplifiers", Proc. IRE, Volume 50, October 1962

9. Bossard, "Low Noise Microwave Amplifiers", RCA Engineer, 1963

10. Bossard, Perlman, "Tunable Solid State Microwave Power Source", SWITEGO, 1963

11. Perlman, Bossard, "Efficient High Level Parametric Frequency Converters", Part III IEEE National Convention Record, 1963

12. Bossard, Mehlman, Newton, "One Watt Tunable Solid State Power Source for the 4.4 to 5.0 GHz Communications Band", East Coast Navigational Electronics Conference, 1963

13. Pan, Bossard, Burns, Chang, "Systems Concepts of Microwave Communications", NEREM (Invited Paper) 1964

PUBLICATIONS AND PRESENTATIONS continued:

14. Bossard, Torrione, Yuan, "Theory and Improvement of Intermodulation Distortion in Mixers", Tri Service Electromagnetic Compatibility Conference, 1964

15. Pan, Bossard, Yuan, Becker, Torrione, "Receiver Distortions and Reductions", University of Pennsylvania, Summer Lecture Series, 1965

16. Pan, Bossard, Yuan, Becker, Torrione, "Systems Concepts of Radio Interference", University of Pennsylvania, Summer Lecture Series, 1964

17. Bossard, "Communications Applications of Cryogenic Techniques", National Science Foundation, University of Colorado, Summer Lecture Series, 1965

18. Perlow, Bossard, "High "Q" Filter Using Feed Forward Techniques", SWIEECO, Dallas, Texas, 1966

19. Perlow, Bossard, "Effective Receiver Dynamic Range Enhancement", Frequency 1966

20. Perlow, Torrione, Bossard, "Balloon Communication System", RCA Engineer, 1966

21. Bossard, "Effective Receiver Dynamic Range Enhancement", Frequency, 1966

22. Bossard, "Single Frequency Radar Concept", Pratt (Invited Lecture Series) 1965

23. Guest of Honor, Pratt University ETA Kappa Nu and Tsu Beta Pi, Graduation 1965

24. Bossard, Markard, Levine, "Co-Channel Intermodulation and Cross Modulation Reduction Circuit", Proc. IEEE, December 1967

25. Bossard, Communication Systems, Northeastern University, Lecture Series, 1986

26. Bossard, "Microwave Solid State Devices", Boston Chapter, PGMTT, Invited Speaker, April, 1970

27. Perlow, Bossard, " Microwave Transistor Specifications", Microwaves, July, 1970

PUBLICATOINS AND PRESENTATIONS continued:

28. Bossard, "Emerging Technologies" Tela-Stratagies, Guest Speaker, Washington, DC December 1991

29. Bossard, Emerging Technology, SCTE, New Orleans, LA, Guest Speaker, Jan. 7, 1993

30. Bossard, Mercer College, Guest Speaker, March 29, 1993

31. Bossard, Virginia Military Institute, Guest Speaker, April 16, 1993

32. Bossard, Optical Fiber Conference, Phoenix, AZ, Guest Speaker, March 11, 1993

33. Bossard, Satellite and Terrestrial Communications, Societyof Satellite Professionals, New York, NY, Guest Speaker, March 31, 1993

34. Bossard, Wireless Communications, Guest Speaker, Washington, DC April 1,1993

35. Bossard, Fordham University Media Club, Guest Speaker, April, 1993

36. Bossard, Milimeter Wave Communications, Canadian Televison Assoc., Toronto, Canada May 12, 1993

37. Bossard, Conference on Vehicular Technology, Guest Speaker, May 18, 1993

38. Bossard, Cable Television Lab, Brickenridge, Colorado, Guest Speaker, July 27, 1993

39. Bossard, Wireless Local Loop Comex Conference, London, England, Guest Speaker, October 1993

Georgia Institute of Technology
Georgia Tech Research Institute

BIOGRAPHICAL SKETCH

BARNHART, ERIC N.--Division Chief
Communications and Networking Division
Information Technology and Telecommunications Laboratory

Education

M.S.E.E., Georgia Institute of Technology	1985
B.E.E., Auburn University	1982

Employment History

Georgia Institute of Technology	
Chief, Communications and Networking Division	1993-Present
Director, Communications Laboratory	1991-1993
Associate Chief, Communications Systems Div.	1989-1990
Head of Communications Countermeasures Branch	1988-1989
Senior Research Engineer	1990-Present
Research Engineer II	1986-1990
Research Engineer I	1983-1986
Martin Marietta Aerospace, Orlando Division	
Engineering Aide	1979-1981

Experience Summary: Has administrative, technical and budget responsibility for the Communications and Networking Division. Presently oversees sponsored programs in commercial telecommunications and military C3I systems and countermeasures. Responsible for the development and management of GTRI systems and technology programs related to these research areas. Is a member of the staff of the Georgia Center for Advanced Telecommunications Technology (GCATT). Currently is involved in the investigation of indoor propagation and the development of Personal Communications Network (PCN) services and equipment. Is also currently involved in development of interactive cable system trial for distance learning. Recently involved in the development of adaptive, spread-spectrum communications systems and techniques. Also investigated cosite interference mitigation techniques. Has conducted vulnerability analysis and testing of multichannel secure communications systems for tactical and strategic applications. Has experience in the performance analysis and operational testing of intercept systems, and foreign equipment exploitation and analysis. Has experience in the analysis and computer modeling of coded, spread-spectrum digital communications systems to investigate system vulnerability with respect to interception and disruption by jamming. Has experience with propagation analysis/modeling from HF through millimeter-wave frequencies, threat evaluation and wideband signal processing. Has hardware design experience with discrete digital systems, and hardware/software development experience with microprocessor based systems. Also has worked on systems integration, calibration, and testing of millimeter-wave radar seeker/guidance systems and temperature control systems. Active as a consultant to government and industry.

Current Fields of Interest

Wireless/personal communications; broadband interactive systems; telecommunications/economic development; networks for enterprise integration, distance learning and telemedicine; multimedia and client-server systems and architectures; military communications; communications privacy/security; telecommunication systems and networks; data communications; lightwave communications; intercept/surveillance systems and techniques; countermeasures systems and techniques; communication system vulnerability; modeling; simulation; signal processing.

Registrations and Special Honors

Registered Professional Engineer, Georgia
General Chairman, 1993 National Telesystems Conference
Wireless Technology Consultant, Sun Features/L.A. Times Syndicate
National Science Foundation Small Business Innovative Research (SBIR) Proposal Review Board in Communications and Networking
Scientific Advisory Board - International Tele-Marine Corporation
Telecommunications Technology Consultant to Caribbean Association of National Telecommunications Organizations (CANTO)
Member: IEEE, IEEE Communications Society, Communications Systems Engineering Committee, Radio Communications Committee, Vehicular Technology Society, Aerospace and Electronic Systems Society; Society of Photo-Optical Instrumentation Engineers; Association of Old Crows; Armed Forces Communications Electronics Association; Tau Beta Pi, Eta Kappa Nu; IVHS America

Major Reports and Publications

1. "An Analysis of Millimeter-Wave Wireless Local Area Networks for LPI/AJ Command Post Communications," Proceedings of the 1993 Military Communications Conference, Boston, Massachusetts, October 1993, coauthor
2. "Distance Learning Via a Caribbean Teleconference Network," Record of the CANTO 1993 Conference and Trade Exhibition, Oranjestad, Dutch Caribbean, June 1993
3. "A Proposed Vocational Education Network: Training, Economic and Technical Implications," Proceedings of the 15th Pacific Telecommunications Conference, Honolulu, Hawaii, January 1993
4. "Trends in Multipath Delay Spread from Frequency Domain Measurements of the Wireless Indoor Communications Channel," Proceedings of the Third International Symposium on Personal, Indoor and Mobile Radio Communications, Boston, Massachusetts, October 1992, coauthor
5. "Mathematical Expressions and Algorithms for Cell Evaluation Tool," Final Report, Project A-9065-200, September 1992, coauthor
6. "Interim Technical Report Number 1: Experimental Licenses KK2XBA and KK2XBB," Interim Report, Federal Communications Commission, August 1992, coauthor

7. "Georgia: Well-Positioned for the Telecommunications Revolution." Computer Currents Magazine, Vol. 4. No. 8. August 1992
8. "Prototype Implementation of an EHF Switched-Beam Array Controller." Final Report, Project A-8200. August 1992. coauthor
9. "Propagation Characterization in Support of BellSouth Personal Communications Services Development." Final Report. Project A-9041, April 1992, coauthor
10. "Propagation Measurements in Support of Hitachi Wireless Communications Model Development." Final Report, Project A-9065-100, March 1992, coauthor
11. Full Speed Ahead for Wireless Access Systems," Guest Expert Section, Computer Currents Magazine, Vol.3, No.10, October 1991
12. "Statistical Data from Frequency Domain Measurements of the Indoor PCN Communication Channel," Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, London, England, United Kingdom, September 1991, coauthor
13. "Test Plan for Hitachi In-Building Communications Channel Characterization," Interim Report, Project B-699, August 1991, coauthor
14. "GUARDRAIL/Common Sensor Upgrade and Environment Analysis," Final Report, Project A-8418, June 1991, coauthor
15. "Electronic Warfare Vulnerability Assessment Process Demonstration Design," Proceedings of the Georgia Tech ECCM Workshop, Atlanta, Georgia, April 1991, coauthor
16. "Characterization of Propagation in Support of Personal Communications Services Development," Final Report, Project A-8756, April 1991, coauthor
17. "Advances in Wireless Communications Systems and Technology," Conference Record of SOUTHCON/'91, Atlanta, Georgia, March 1991
18. "Characterization of Indoor Propagation for Personal Communications Services," Conference Record of SOUTHCON/'91, Atlanta, Georgia, March 1991, coauthor
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